# Sanitary Surveys: Success and Opportunities for the Future

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What are sources – Great Lakes?

**Reported Sources Causing Beach Actions
in Great Lakes States in 2005
*(1,481 actions)***

Storm 7%
Other 3%
Unknown 90%
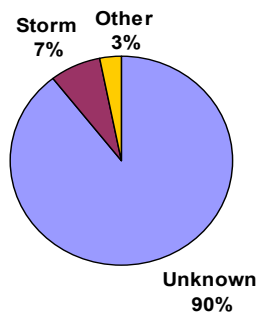
C. Kovatch, USEPA National Beaches Conference, 2006

Motivation for Action

- **Public perception/expectations**
  - **Citizens value utility as condition of residence**
- **Economic issues**
- **Social issues**
  - **Equity with regards to access**
- **Environmental protection/preservation**
  - **Coastal habitat**
  - **Fisheries and wildlife**
- **Public health**

Wisconsin's Beaches chosen for Sanitary Surveys

- Widespread locations for comparative analyses

- 18 beaches

Beach Sanitary Surveys – Goal

To explore and accurately characterize beaches along Lake Michigan and Lake Superior in terms of identifying possible sources of microbial pollution entering the beach area.

Beach Sanitary Surveys:
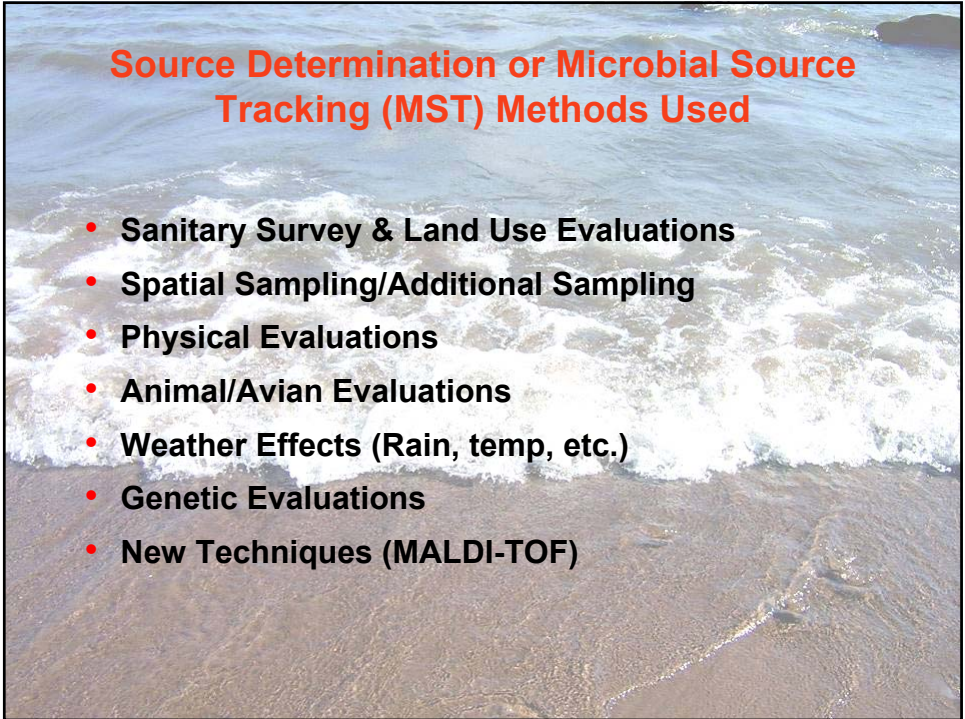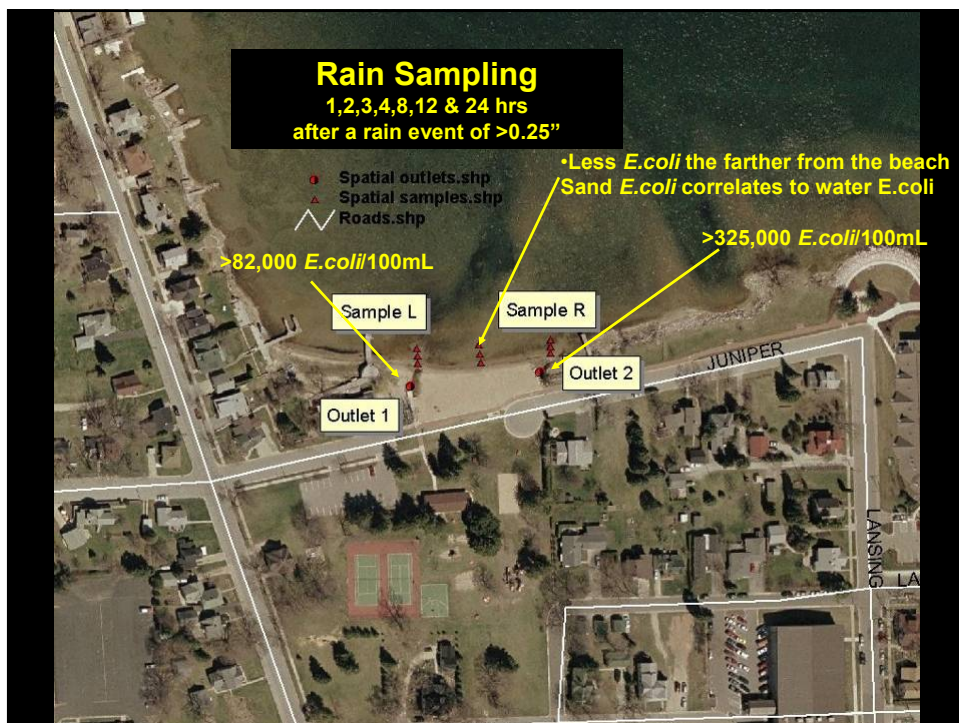
Beach Sanitary Surveys:
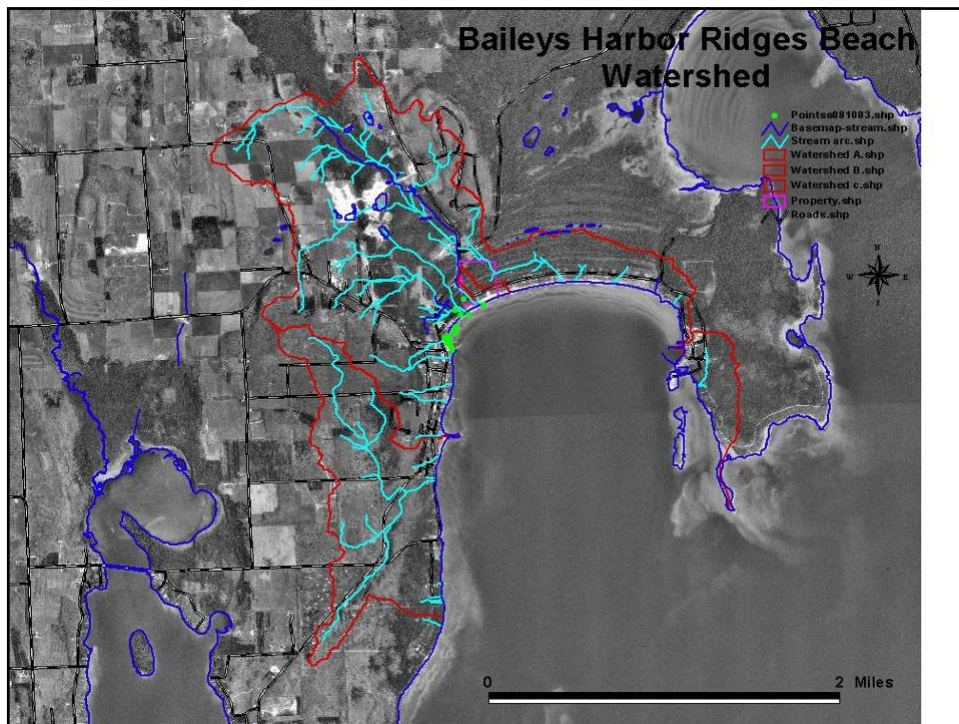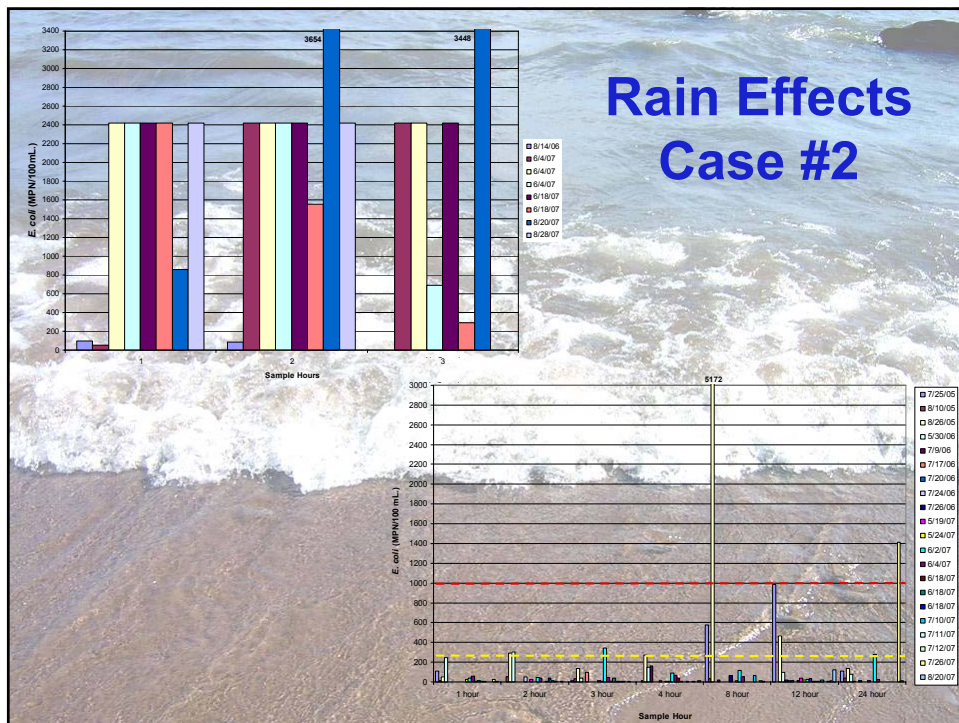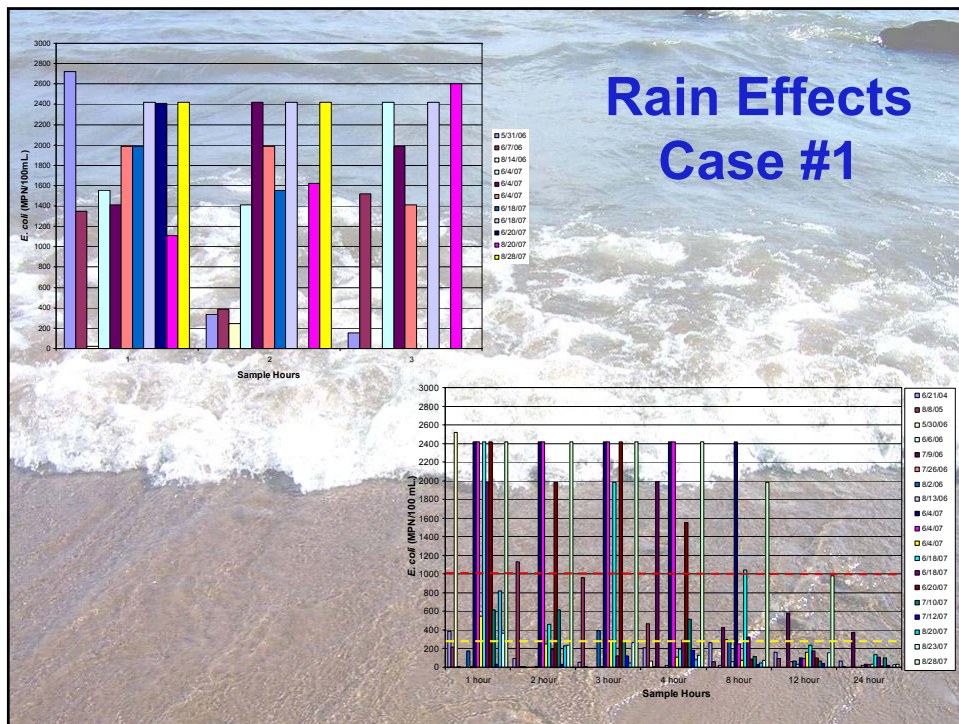

Beach Sanitary Surveys:

Tools Used in Sanitary Survey Project

Source Determination or Microbial Source Tracking (MST) Methods Used

- **Sanitary Survey & Land Use Evaluations**
- **Spatial Sampling/Additional Sampling**
- **Physical Evaluations**
- **Animal/Avian Evaluations**
- **Weather Effects (Rain, temp, etc.)**
- **Genetic Evaluations**
- **New Techniques (MALDI-TOF)**

Baileys Harbor Ridges Beach Watershed

Rain Sampling
1,2,3,4,8,12 & 24 hrs
after a rain event of >0.25"

•Less *E.coli* the farther from the beach
•Sand *E.coli* correlates to water E.coli

>82,000 *E.coli*/100mL

>325,000 *E.coli*/100mL

Spatial outlets.shp
Spatial samples.shp
Roads.shp

Sample L

Sample R

Outlet 1

Outlet 2

JUNIPER

LANSING LA

Rain Effects Case #1

Rain Effects Case #2

Case #1

Overall Evaluation and Data Analysis

Overall Impact

(ANOVA-Overall)

Beach	p-value
Baileys Harbor	0.000
Whitefish Dunes	0.110
Egg Harbor	0.849
Murphy Park	0.000
Sister Bay	0.000
Ellison Bay	0.000
Sunset	0.011
Nicolet	0.041

Case #2

	Seasonal Mean	1-3 hour mean	8 hour sample	12 hour sample	24 hour sample
Seasonal Mean	1.000				
1-3 hour mean	0.000	1.000			
8 hour sample	0.000	0.467	1.000		
12 hour sample	0.024	0.031	0.853	1.000	
24 hour sample	0.754	0.000	0.119	0.647	1.000

	Seasonal Mean	1-3 hour mean	8 hour sample	12 hour sample	24 hour sample
Seasonal Mean	1.000				
1-3 hour mean	1.000	1.000			
8 hour sample	0.967	0.955	1.000		
12 hour sample	0.973	0.987	0.862	1.000	
24 hour sample	1.000	0.999	0.995	0.976	1.000

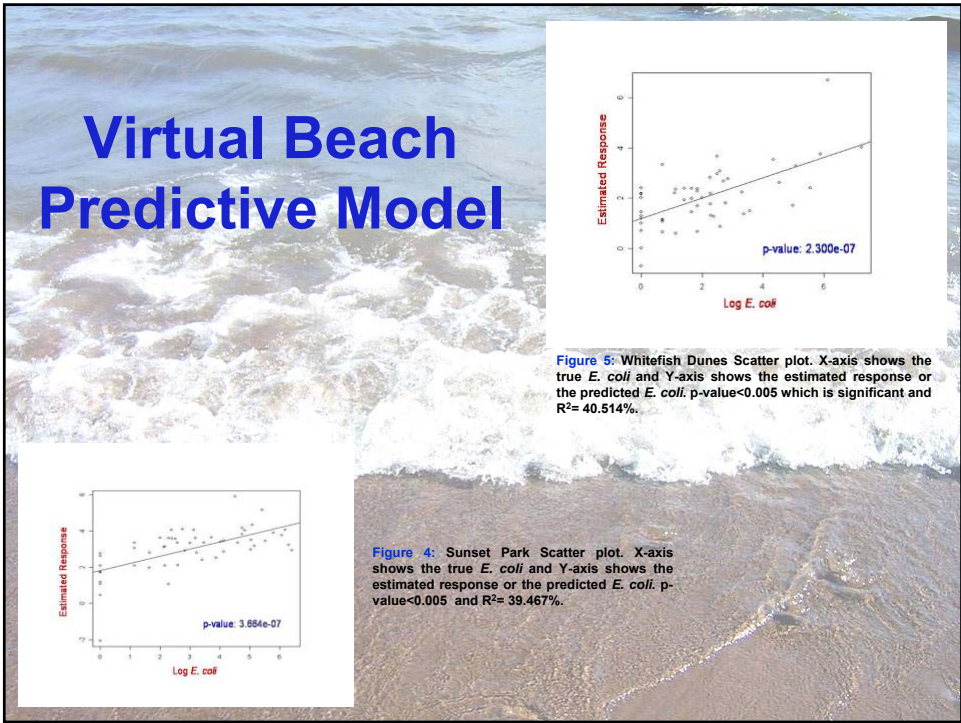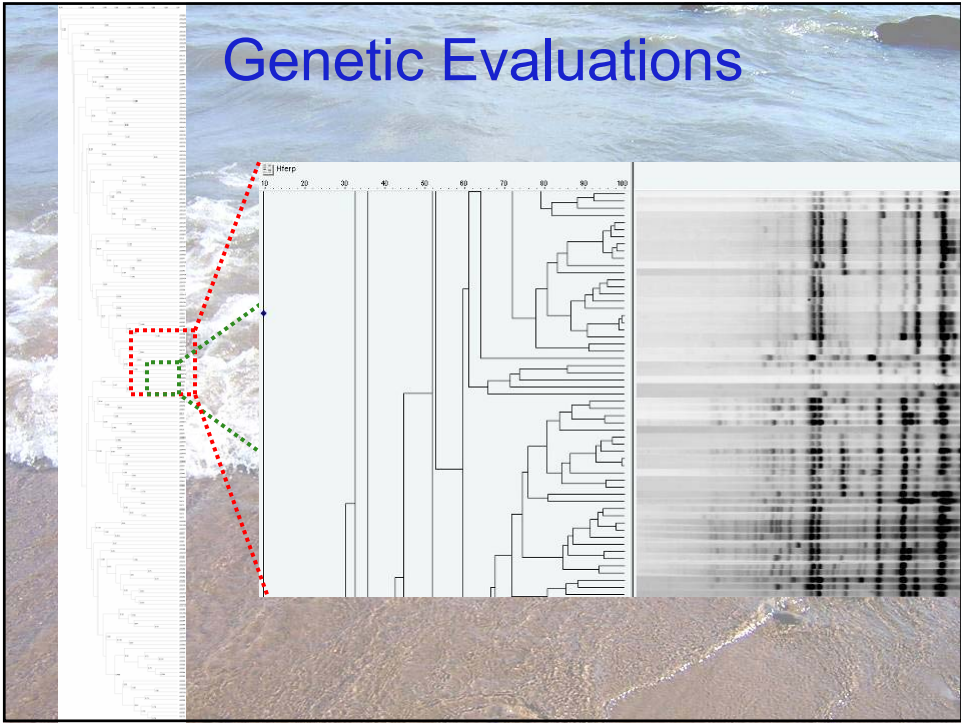Whitefish Dunes *E. coli* in Water - Event 2

E.coli and Sand

Table 1. Beaches included in the sand evaluation study and summary of data from 2005.

Beach	Mean Upshore Sand *E.coli* CFU/g	Mean Swash Sand *E.coli* CFU/g	Mean Submerged Sand *E.coli* CFU/g	Mean *E.coli* from water MPN/100mL
Baileys Harbor	56.6	106.5	3.5	169.8
Ephraim Beach	43.6	52.2	7.8	134.6
Fish Creek	73.7	137.9	8.7	196.9
Otumba Park	18	190.4	11.9	335.4
Sunset Park	99.4	136.7	58.1	107.3
Whitefish Dunes	216.7	91.5	2.8	259.5

Table 2. Beaches included in the sand evaulation study and summary of data from 2006.

Beach	Mean Upshore Sand *E.coli* CFU/g	Mean Swash Sand *E.coli* CFU/g	Mean Submerged Sand *E.coli* CFU/g	Mean *E.coli* from water MPN/100mL
Baileys Harbor	76.1	31.6	9.8	127.2
Ephraim Beach	13.1	29.3	0.4	38.9
Fish Creek	5.4	21.3	2.4	58.1
Otumba Park	29.7	127.2	11.5	89.4
Sunset Park	59	115.2	21	184.4
Whitefish Dunes	78.7	39.9	1.9	141.3

Genetic Evaluations

Virtual Beach Predictive Model

Figure 5: Whitefish Dunes Scatter plot. X-axis shows the true *E. coli* and Y-axis shows the estimated response or the predicted *E. coli*. p-value<0.005 which is significant and R^2= 40.514%.

Figure 4: Sunset Park Scatter plot. X-axis shows the true *E. coli* and Y-axis shows the estimated response or the predicted *E. coli*. p-value<0.005 and R^2= 39.467%.

Beach Sanitary Surveys:
Potential Contamination Sources

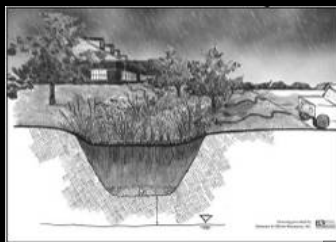| Lake Superior	Lake Michigan
Beach Sand	Beach Sand
Outfalls	Outfalls
Animal Fecal Material on Beach	Large Gull Population & Feces
Runoff through Beach Area	Potential of CSOs
Poor Beach Maintenance	Discharge from WWTPs
	Stormwater Runoff
	Cladophora/Algal Mats

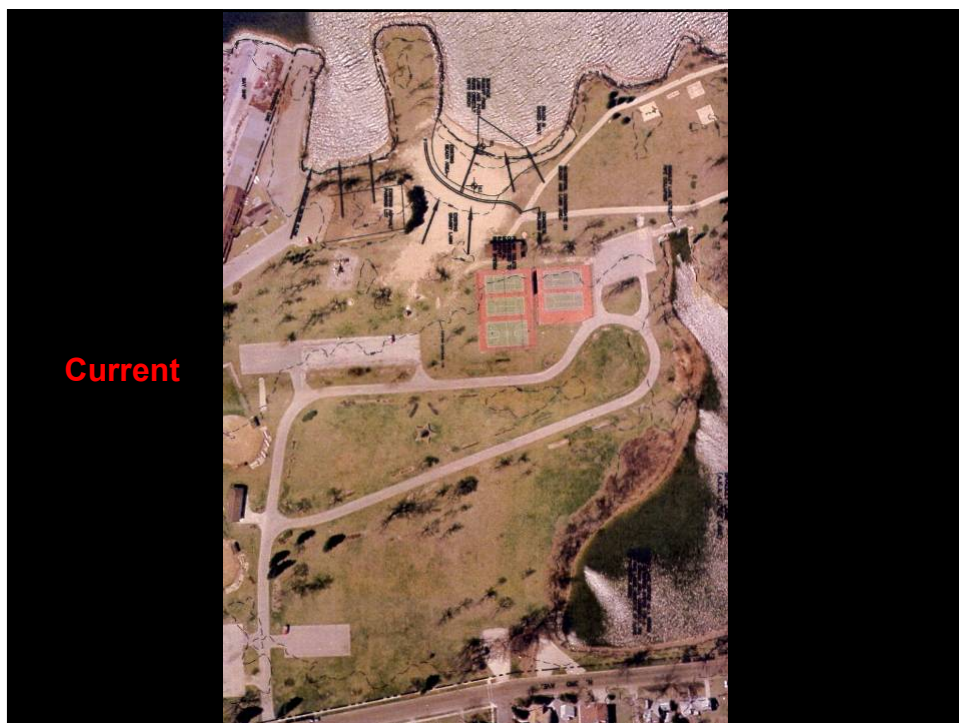**Now that we have all this data…what can we do?**
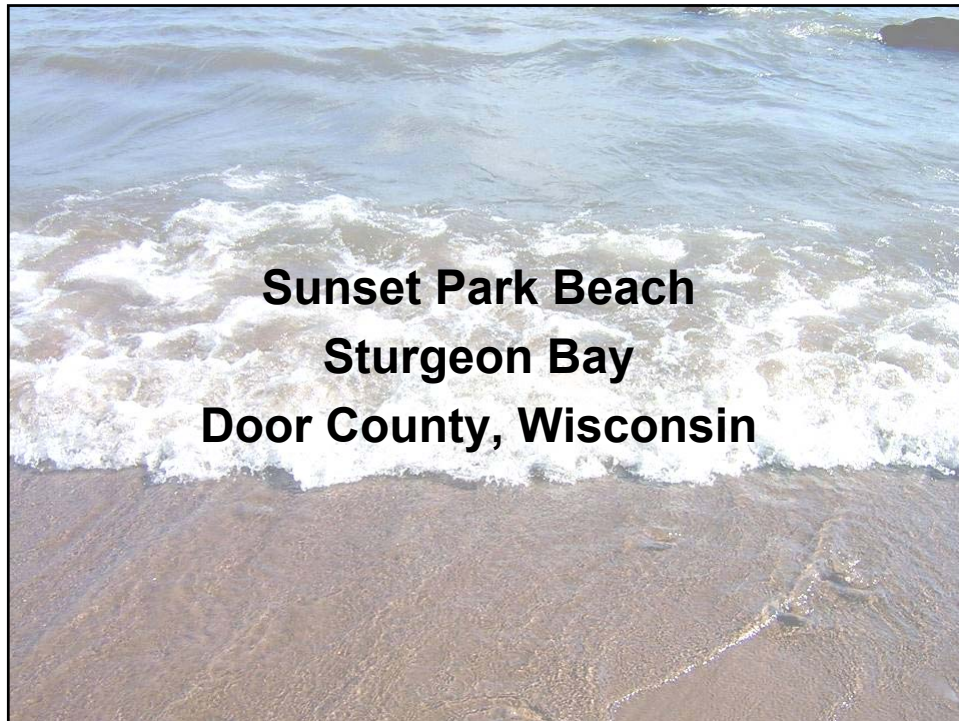
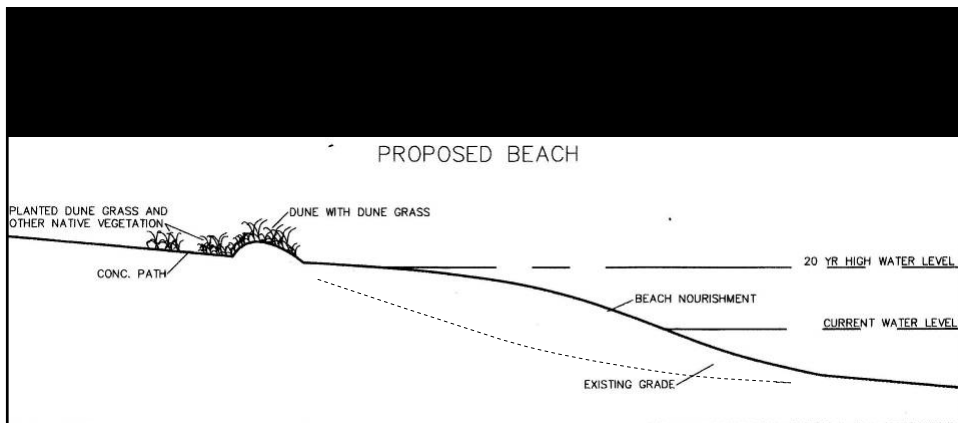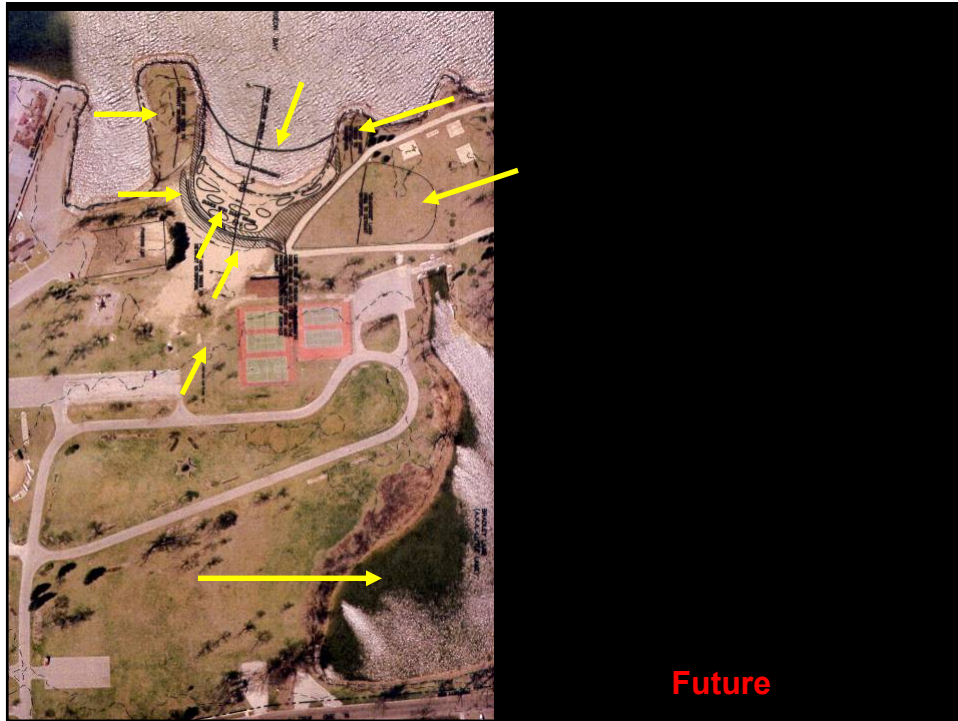**Make a Difference!**

Best Management Practices

- **Regular Maintenance of Storm Sewers and catch basins - Significant source of *E.coli***
- **Street and Impervious Surface Cleaning**
- **Know where pipes 'come from' and 'go'**
- **Beach Grooming - CORRECTLY DONE**
- **Removal of *Cladophora***
- **Storm Water Ordinances**
- **Public Signage/Public Education**
  - **Pick-up pet waste, pick-up trash, Do Not feed birds, etc.**
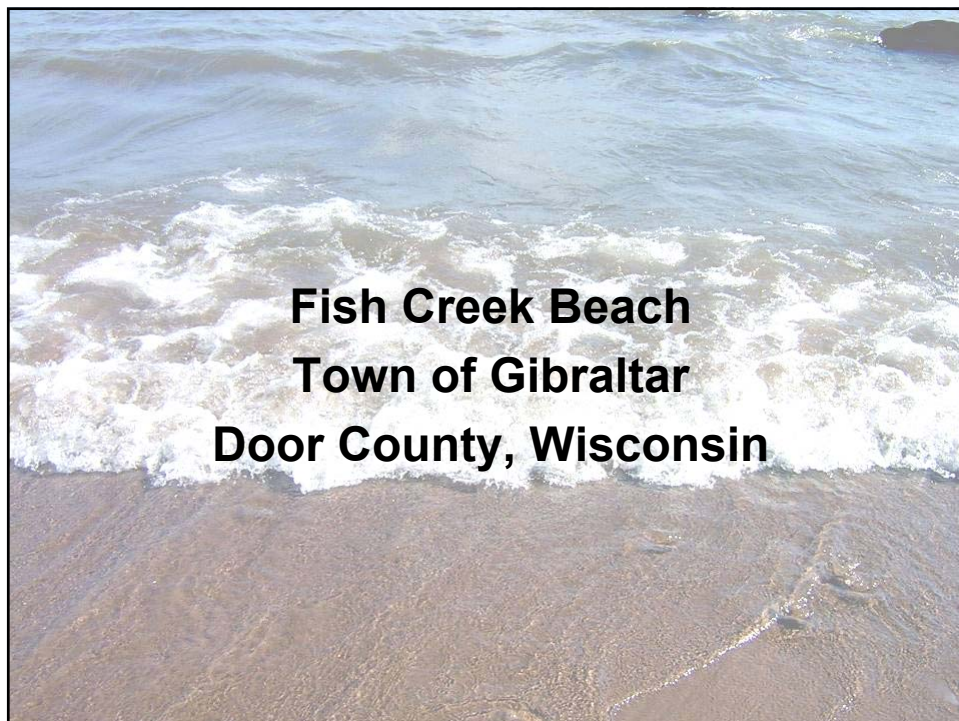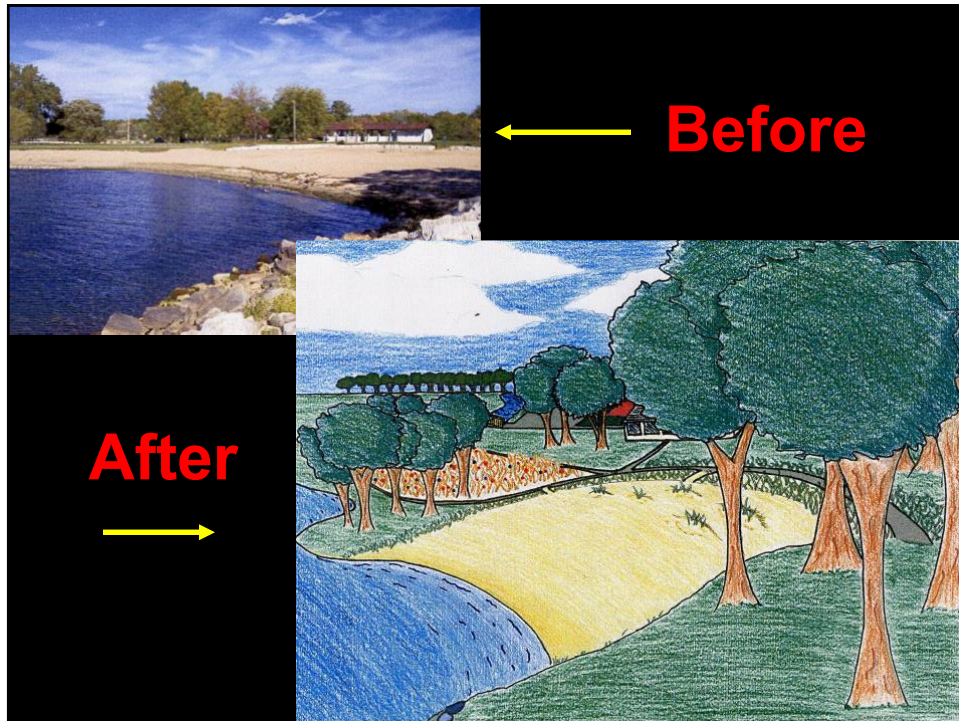- **Others?**

Storm Water Infiltration

Graphics Courtesy of Rice Creek Watershed District

Sunset Park Beach
Sturgeon Bay
Door County, Wisconsin

Current

Future

PROPOSED BEACH

PLANTED DUNE GRASS AND OTHER NATIVE VEGETATION

DUNE WITH DUNE GRASS

CONC. PATH

20 YR HIGH WATER LEVEL
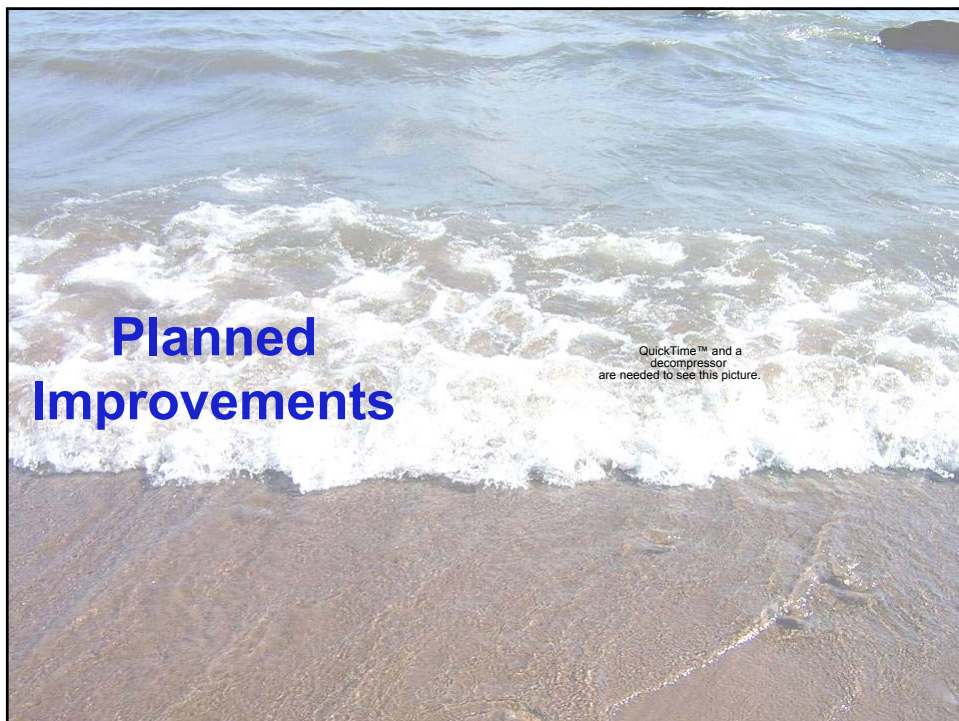
BEACH NOURISHMENT

CURRENT WATER LEVEL

EXISTING GRADE

Beach Nourishment
- Improved water flow
- Decreased size of swash zone
- Improved filtration
- Increased beach area
- Aesthetic improvement

14

Before

After

Fish Creek Beach
Town of Gibraltar
Door County, Wisconsin

Existing Conditions

Planned Improvements

QuickTime™ and a
decompressor
are needed to see this picture.

Current

Future

Beach Sanitary Surveys:

Recommended Remediation Measures

- Better beach maintenance

- Stormwater runoff controls (diverting outfalls, vegetated swales, eliminating sources of seeps)

Bank Stabilization with Native Plants at Zoo Beach (Racine, WI)

Beach Sanitary Surveys:
Recommended Remediation Measures

- Removal of fecal material at beaches
- Cladophora (algae) removal
- Gull population control

All beaches are located in Door County, WI. These parameters and costs are based upon conceptual designs presented to each municipality. Final engineered plans should be completed in early 2008.

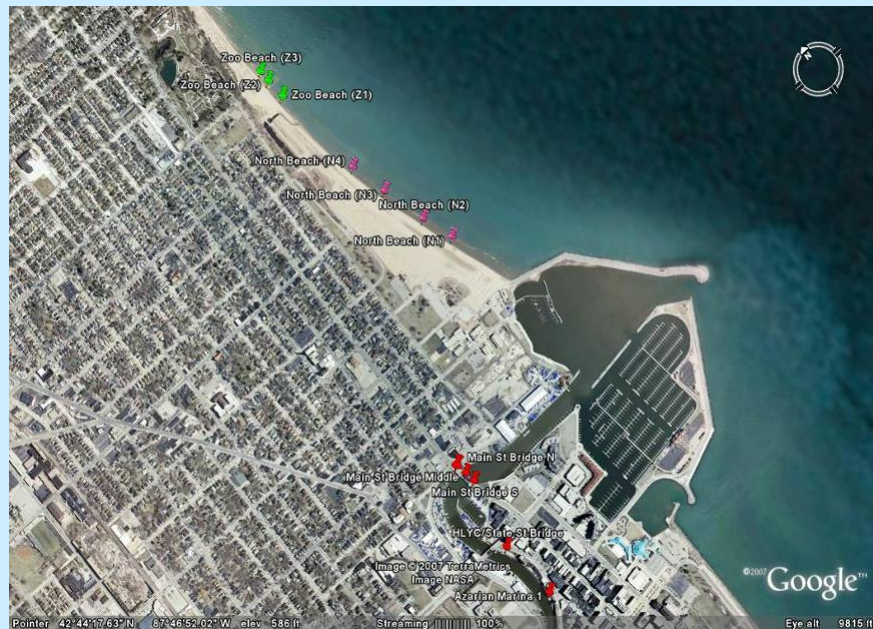| Beach Name	Testing and Source Tracking Conducted on this Location	Proposed beach modifications	Approximate Cost
Egg Harbor	Spatial sampling for *E.coli* surrounding the beach area, *E.coli* in beach sand determinations, genetic source tracking of beach *E.coli*, antibiotic sensitivity testing of *E.coli* found at the beach, a study on the impacts of rain on beach water quality, avian waste studies, and physical/impervious surface characterizations.	• Best Management Practices • Beach nourishment with properly sized sand. • Stormwater infiltration systems • Biofilter system installation for treatment of stormwater. • Removal of jetty • Planting of dune grass and native vegetation.	$50-100,000 depending on options selected in the plans.
Murphy Park	Same as above.	• Best Management Practices • Beach nourishment with properly sized sand. • Stormwater infiltration systems • Planting of dune grass and native vegetation. • Possible removal of adjacent pier.	$83,000 The removal of the large pier could cost an additional $150,000.
Anclam Park	Same as above.	• Best Management Practices • Beach nourishment with properly sized sand. • Stormwater infiltration systems • Redesign of flow-through pier adjacent to beach. • Redirection of stormwater discharge. • Planting of dune grass and native vegetation. • Installation of Vortechs system.	$78,000 with the $50,000 Vortechs system possibly being paid for by the WI DOT during highway reconstruction.
Ellison Bay	Same as above.	• Best Management Practices • Beach nourishment with properly sized sand. • Biofilter system installation for treatment of stormwater. • Removal of driveway and other impervious surfaces adjacent to the beach. • Install a vegetative barrier to discourage geese from migrating to the beach – thick vegetative berm. • Stormwater infiltration systems • Redesign of flow-through pier adjacent to beach. • Redirection of stormwater discharge. • Planting of dune grass and native vegetation. • Re-grade adjacent park.	$95,000

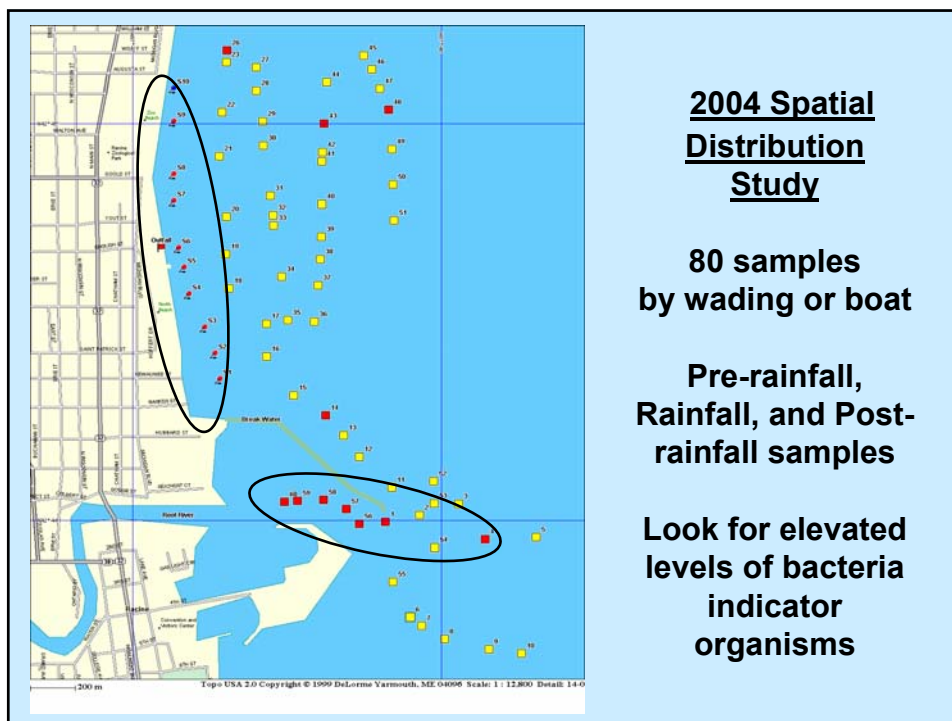|			
Baileys Harbor Ridges Park Beach	Same as above.	• Best Management Practices • Beach nourishment with properly sized sand. • Redirection of stormwater discharge. • Planting of dune grass and native vegetation. • Re-grade adjacent parking lot.	$47,000
Sister Bay Beach	Same as above.	• Best Management Practices • Beach nourishment with properly sized sand. • Stormwater infiltration trenches. • Biofilter system installation for treatment of stormwater. • Redesign of flow-through pier adjacent to beach. • Redirection of stormwater discharge. • Planting of dune grass and native vegetation.	$175,000
Fish Creek Beach	Same as above.	• Best Management Practices • Beach nourishment with properly sized sand. • Biofilter system installation for treatment of stormwater. • Removal of some impervious surfaces adjacent to the beach area. • Repair of storm sewers adjacent to the beach to decrease overland flow. • Redirection of stormwater discharge. • Planting of dune grass and native vegetation.	$55,000
Lakeside Park Beach	Same as above.	• Best Management Practices • Beach nourishment with properly sized sand. • Installation of two rain gardens to treat stormwater runoff. • Removal of some impervious surfaces adjacent to the beach area. • Redirection of stormwater discharge. • Planting of dune grass and native vegetation.	$145,000
Ephraim	Same as above.	• Best Management Practices • Beach nourishment with properly sized sand. • Installation of a rain gardens to treat stormwater runoff. • Removal of some impervious surfaces adjacent to the beach area. • Removal of foot wash station and its runoff. • Redirection of stormwater discharge. • Planting of dune grass and native vegetation.	$75,000
Otumba Park Beach	Same as above.	• Best Management Practices • Beach nourishment with properly sized sand. • Stormwater infiltration systems • Redirection and movement away from the beach of stormwater discharge – pipe extensions. • Planting of dune grass and native vegetation. • Installation of four Vortechs system.	$450,000

Potential Local Sources
Racine, WI

- Indirect or Non-Point Source
  - Run-off (Impervious surface, Landscape)
  - Algae
  - Submerged sediments, Beach Sands
- Direct or Point Source
  - CSO (regional)
  - Boaters
  - Bathers
  - Storm Drains (infrastructure malfunctions)
  - River (would also include NPS)

Where we found pollution & *What* the source likely was

- **Local influences are predominant (spatial distribution)**

- **Regional influences unlikely (spatial distribution)**

- **Primarily beach sands and storm water discharge (spatial distribution)**

- **Algal mats may contribute if not removed (spatial distribution)**

- ***E. coli* in beach sands likely due to gulls (PCR, ARA)**

- **Storm water may have mixed human and non-human sources – human specific *Bacteroides* detected in some samples (ARA + *Bacteroides*)**

- **Some potential for riverine influences under right conditions – also mixed human and non-human sources (ARA + *Bacteroides*)**

2004 Spatial Distribution Study

80 samples by wading or boat

Pre-rainfall, Rainfall, and Post-rainfall samples

Look for elevated levels of bacteria indicator organisms

When were Bathing Water Advisories Occurring?

- Wind Direction
  - East winds associated with 49% of BWQF
- Wave Height
  - 85% of BWQF occurred when waves were ≥ 1.0 ft.
- Precipitation
 - Only 42% of BWQF were preceded by precipitation

Municipal Remediation Measures

- **Reduce Impacts of Storm Water**
- **Remove Algae**
- **Reduce Amount of *E. coli* In Beach Sands**

Basin Assessment @ English St.

- 150 cm pipe
- Drainage area 395.5 acres (160.05 hectares)
- Land Use
  - 20-25% HD residential
  - 20-22% multi-family
  - 15-20% MD residential
  - 12-15% Commercial
  - 5-10% Industrial
  - 5-6% Open space
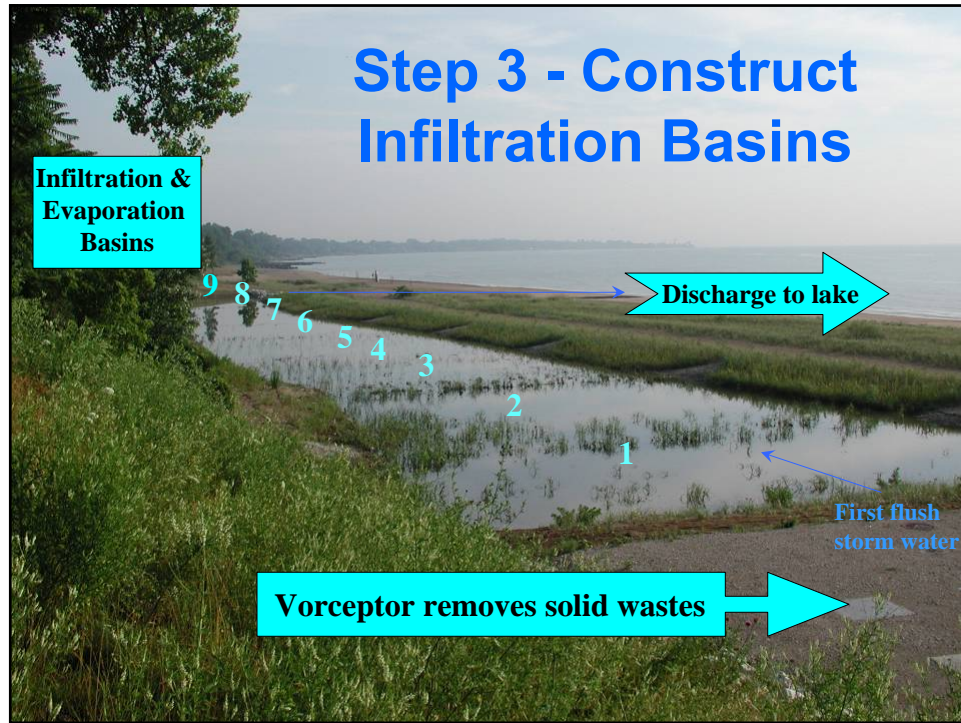 - 1-2% Office, Institutional
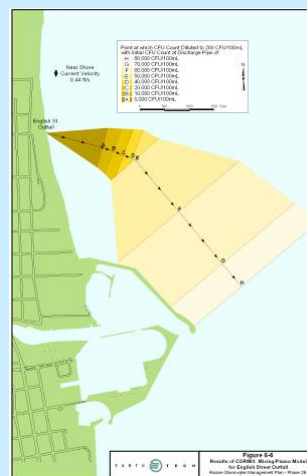
Storm Drain Televising

- Severely cracked pipes at several points downstream
- Sanitary sewer defects
- Defects in laterals (sanitary infiltration)
- Deposits in catch basins
- Illicit discharge to storm drain system

Step 1 -Outlet Relocated

Step 2 - Chamber Installation

11. 7. 2000

Step 3 - Construct Infiltration Basins

Infiltration & Evaporation Basins

9 8 7 6 5 4 3 2 1

Discharge to lake

First flush storm water

Vorceptor removes solid wastes

Outfall Maintenance

- Inspect annually and after rain events of 5 cm
- Inspect sediment level in grit chamber quarterly
- Clean grit chambers annually
- Dry and landfill solid waste

Bypass Outlet

Current Wetland Area

Algae (*Cladophora*)

- Algae contains bacterial indicators
  - *E. coli* ≥ 25,000 cfu/ml
  - enterococci = 800 cfu/ml

- If indicators are persistent in algae they may contribute to FIB burden
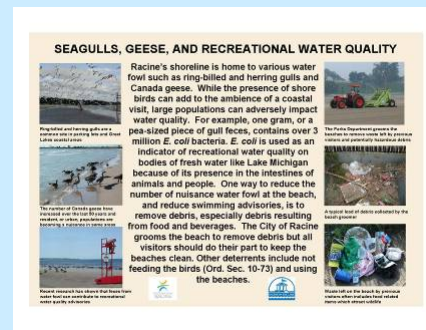
Beach Grooming/Beach Slope Maintenance

- *E. coli* content in beach sands is influenced by the moisture content
- Large swales trap water and remain wetted
- Flat beach face allows for the encroachment of waves
- Deep beach grooming w/o leveling can promote drying

Helpful Hints…

- BSS will provide you with the information you need to determine pollutant sources
- Don't be overwhelmed by the process
- Take a partnership approach
  - Public Works, Parks, Water/Wastewater, Health, Local Universities, Volunteers
  - One person does not necessarily have to collect all of the data
  - Some data can be collected pre- or post-beach season
- Be patient, work incrementally
  - It took Racine 5 years to ID all sources and implement remediation sources
- We're all in this together
  - People who have done this are likely willing to act as resources
  - Racine's beach sanitary surveys have been posted on their website
    - www.cityofracine.org, water quality research tab
- Some remediation measures are low/no cost
- Grant funding may be available for research/remediation
- Remediating beaches will benefit your community

Conclusions

- Collect reliable, defendable data on EACH location.
- Determine sources of *E.coli*
  - local/shore-borne
  - regional
- Utilize sustainable remediation approaches with minimal O&M costs whenever possible.
- Beach remediation/redesign will:
  - convert the beach to a more natural setting
  - increase water quality
  - protect public health
  - make each beach more aesthetically pleasing and more user friendly.

Current Initiatives

- Great Lakes Regional Collaboration
  - Coastal Health chapter recommended action
  - Beach project initiative (www.glrc.us, beaches)
    - Examples of completed BSS from 2007 pilot study
    - User manual
    - Blank forms
    - Available April 30, 2008

- Great Lakes St. Lawrence Cities Initiative
  - US and Canadian Mayors
  - Recognize beaches are important to local economies
  - Encourage use of BSS to identify pollutant sources
    - Educate users on predictive modeling
  - http://www.glslcities.org/

Beach Sanitary Surveys: Predictive Models

- Environmental data collected as part of a BSS can be used to begin constructing a predictive model

- Virtual Beach (USEPA model)

- Allows correlations between parameters and water quality (i.e. wave height, wind direction, rainfall, etc.)

- Data limitations prevent full use, i.e. you will likely need multiple years of data

- If funding continues, will use modeling simultaneously with sampling

Thank you!